

# Tools and data to meet MAP 21

**Meeting new Federal reporting requirements by  
enhancing data management & systems**



**Transportation Practice**

# Why the new initiatives?

*MAP 21 changed HPMS and general reporting requirements at a fundamental level*

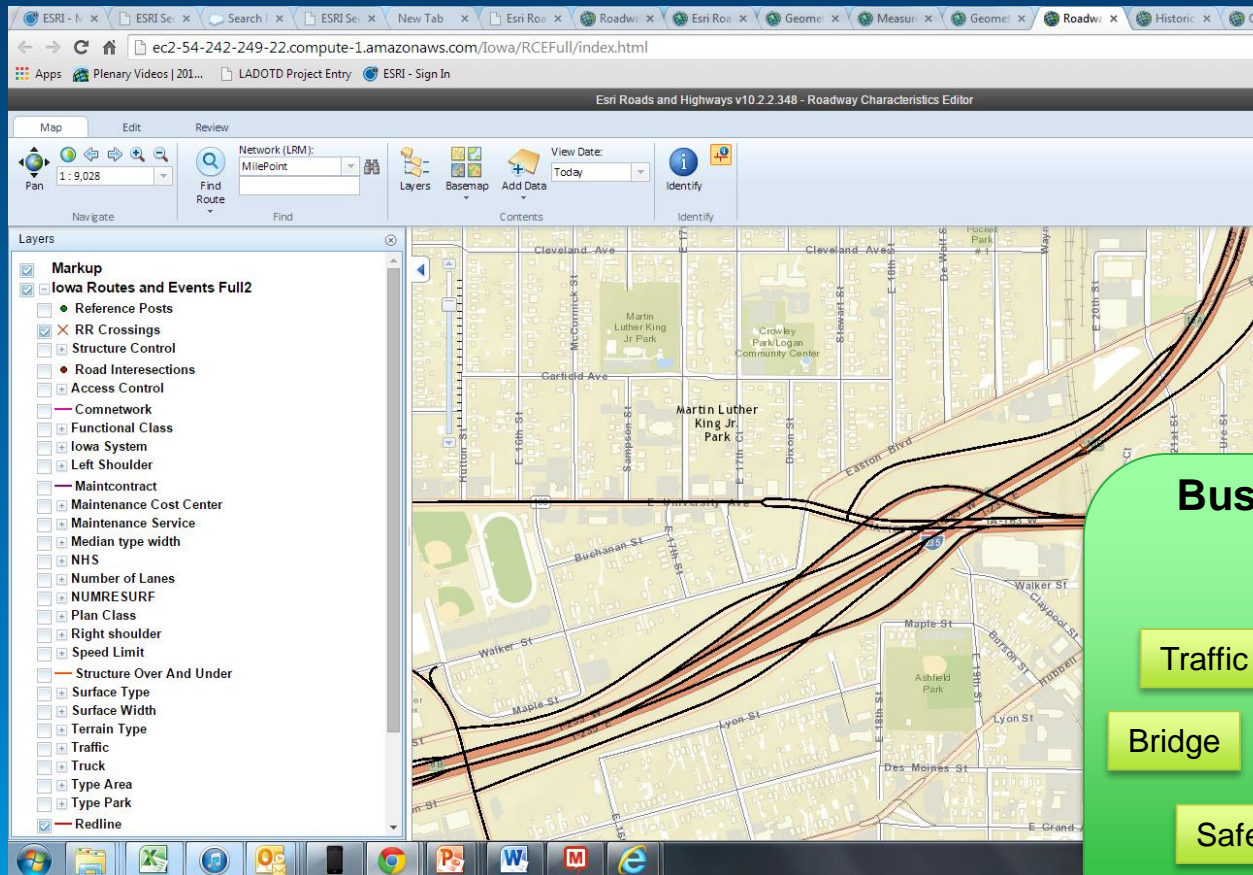
The image shows two side-by-side screenshots. The left screenshot is of the FHWA MAP-21 website, featuring a navigation menu with links like 'ABOUT', 'WHAT WE DO', 'PROGRAMS', 'RESOURCES', 'BRIEFING ROOM', and 'CONTACT US'. The main content area is titled 'MAP-21 Moving Ahead for Progress in the 21st Century' and includes a 'Summary' section with a list of links (Q & A, Fact Sheets, Presentations, Legislation, Funding Tables, Webinars, Guidance) and a 'Recently Added' section with links to '9/25 - Guidance Documents' and '9/25 - Expanded Questions & Answers'. The right screenshot is of the HPMS 2012 catalog, showing a tree view of data items under 'Sections Catalog' and 'Pavement', including 'Base\_Thickness', 'Base\_Type', 'Climate\_Zone', 'Cracking\_Length', 'Cracking\_Percent', 'Faulting', 'IRI', 'Last\_Overlay\_Thickness', 'PSR', 'Rutting', 'Soil\_Type', 'Surface\_Type', 'Thickness\_Flexible', 'Thickness\_Rigid', 'Year\_Last\_Construction', 'Year\_Last\_Improv', 'Route', 'Alternative\_Route\_Number', 'Route\_Number', 'Route\_Qualifier', 'Route\_Signing', 'Special Networks', 'Future\_Facility', 'NHS', 'STRAHNET\_Type', 'Truck', and 'Traffic'.

**All public roads network (ARNOLD)**  
**Dual carriageway representation**  
**Linear Referencing System (LRS) on all roads**  
**Performance measures**

*More changes will come as performance metrics are finalized and released...*

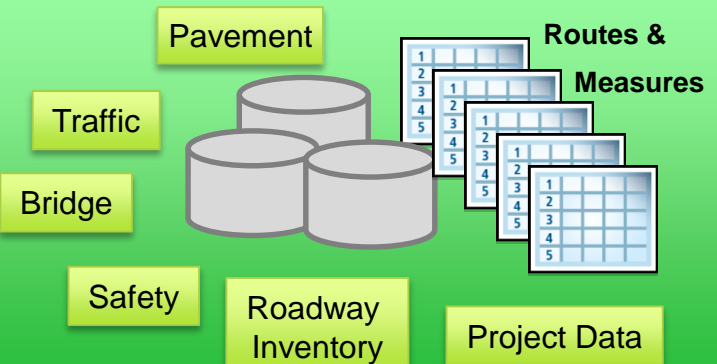
# What did we focus on to meet the challenges?

*MAP 21 changed HPMS and general reporting requirements at a fundamental level*



## Better Integration

### Business Systems



## More Data

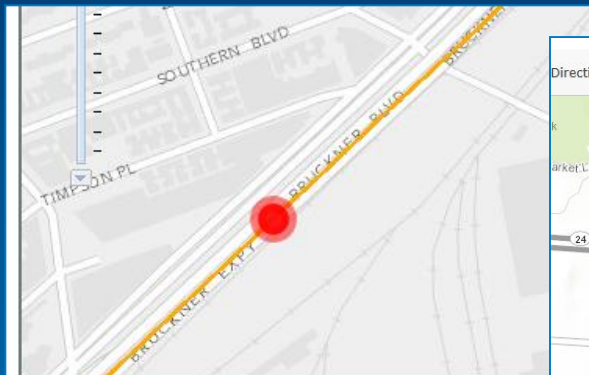
*Meeting the challenges by going to the source of the issue...*



# Maximizing the All Roads (ARNOLD) effort

*Adding more data to an LRSable, geocodable, routable, sustainable, collaborative environment*

## LRSable



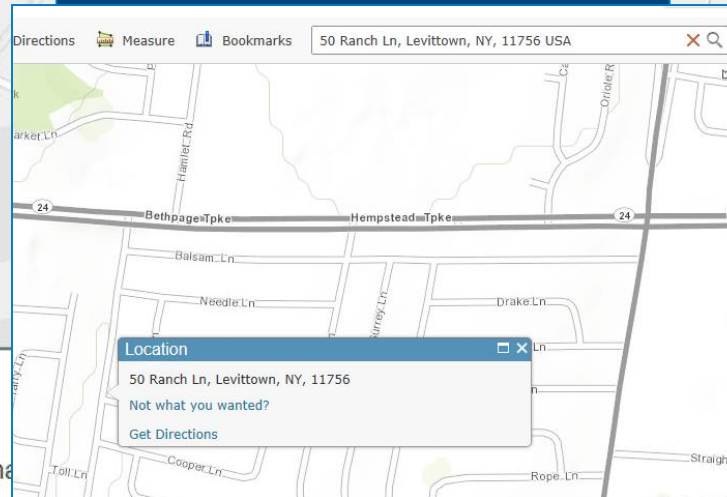
Route ID:

From Measure:

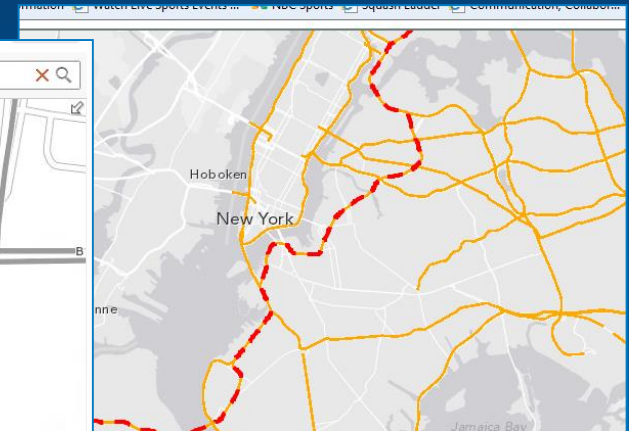
To Measure:

(optional)

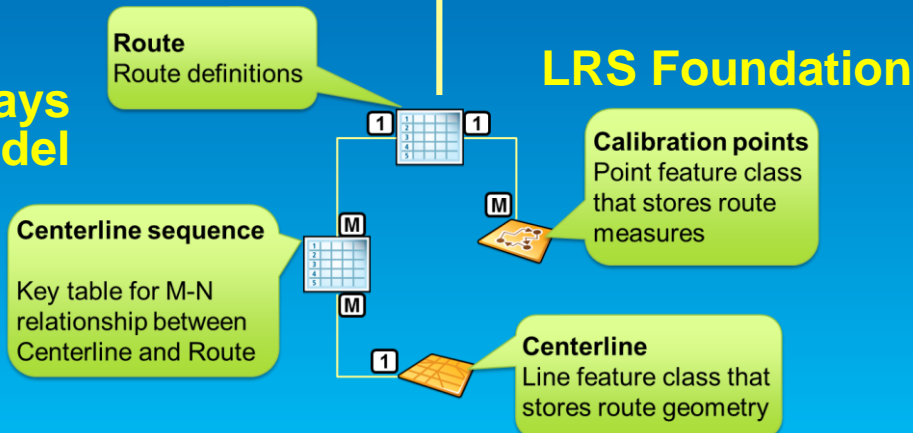
## Geocodeable



## Routable



## Roads & Highways Data Model



# How do we get there?

*Simplicity is key*

- Find data model, tools and processes that support the LRSable, geocodeable, routable, sustainable State-wide centerline file
- Agree on road network geometry across local and State jurisdictions
  - Create edge matching points
  - Conflate LRS, address and routing data
- Recognize the varying levels of technology at collaborating agencies
- Establish collaborative, sustainment processes
- Provide benefits to local, State and regional agencies

# What does the solution look like?

*Create, sustain, collaborate and share*

## Big Bang Event

Establish  
control points  
between jurisdictions



Conflate local,  
state and routing  
data into a  
common geometry

Build initial  
centerline file

## Sustainable Environment

Periodic  
Load



Web  
Input



Local  
Benefits



Conflation



State Data  
Maintenance



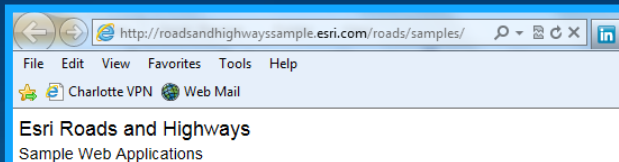
Sharing Content  
and Services



*Providing a State-wide, collaborative system that has benefits for all...*

# What new tools have changed the technology environment?

*New and enhanced Commercial Off-The-Shelf (COTS) products*



## Roads And Highways Editing Mile Point

Visualize routes  
This sample visualizes a route network

Visualize events  
This sample visualizes event layers on a map. Two types of linear events.

Spatial query of routes  
Query a route network layer using a spatial filter.

**COTS LRS  
product  
release**

**Sophisticated  
COTS conflation  
enhancements  
to build initial  
database &  
incorporate  
local changes**

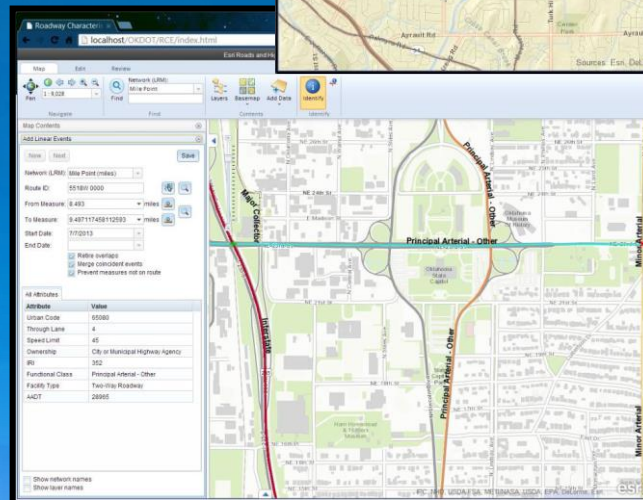
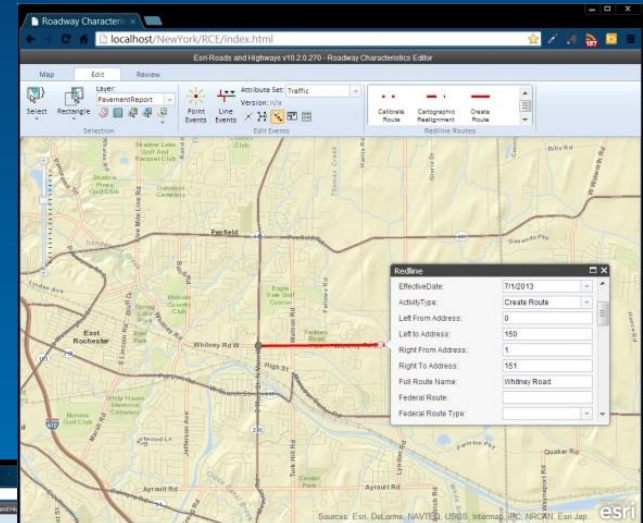
### Editing Tools

#### Conflation

- Edgematch Features
- Generate Edgematch Links
- Generate Rubbersheet Links
- Rubbersheet Features
- Transfer Attributes



**COTS  
Web-based  
Redlining to  
Support local  
collaboration**



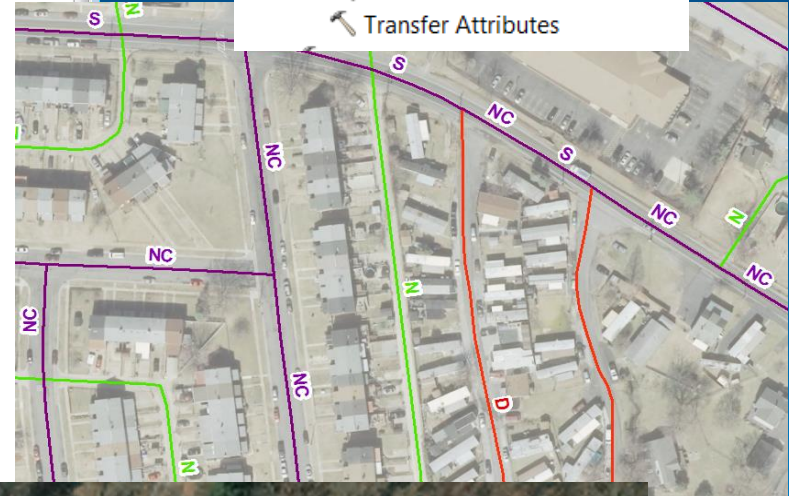
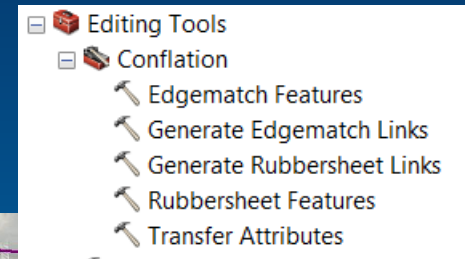
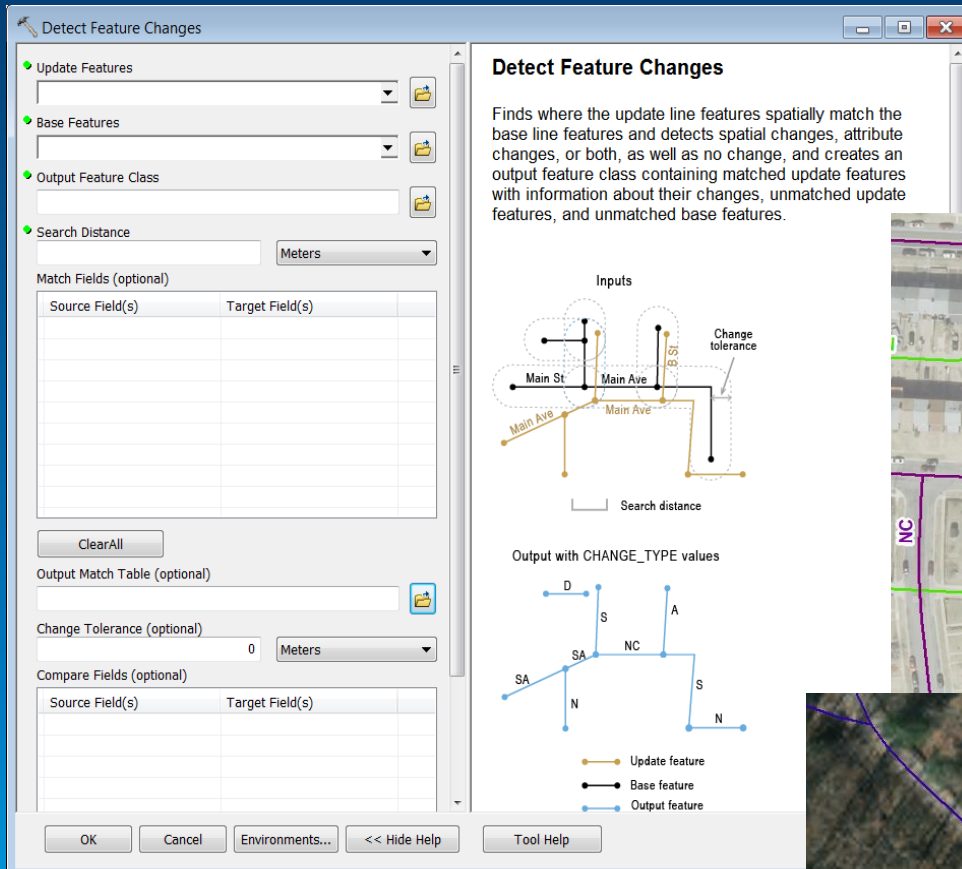
**COTS  
Web-based  
Roadway  
Inventory data  
management**

*Providing a robust data, functionality and collaboration environment*



# Conflation tools in ArcGIS

*Building and sustaining centerline data while minimizing impact on locals*

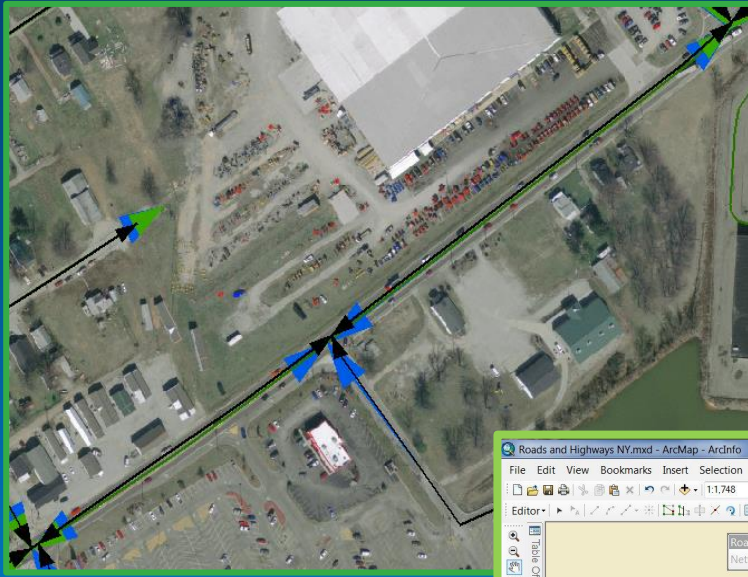




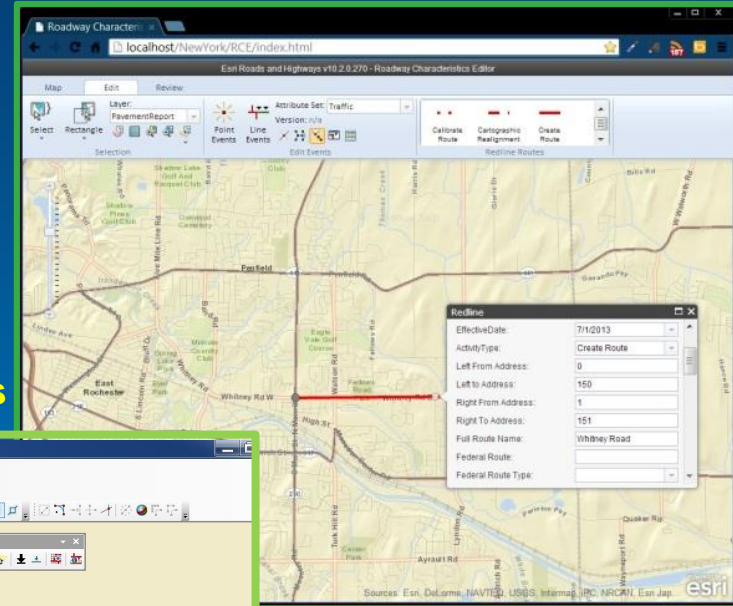
# Sustaining the State-wide centerline file

*The key is minimizing change to local processes while providing benefit*

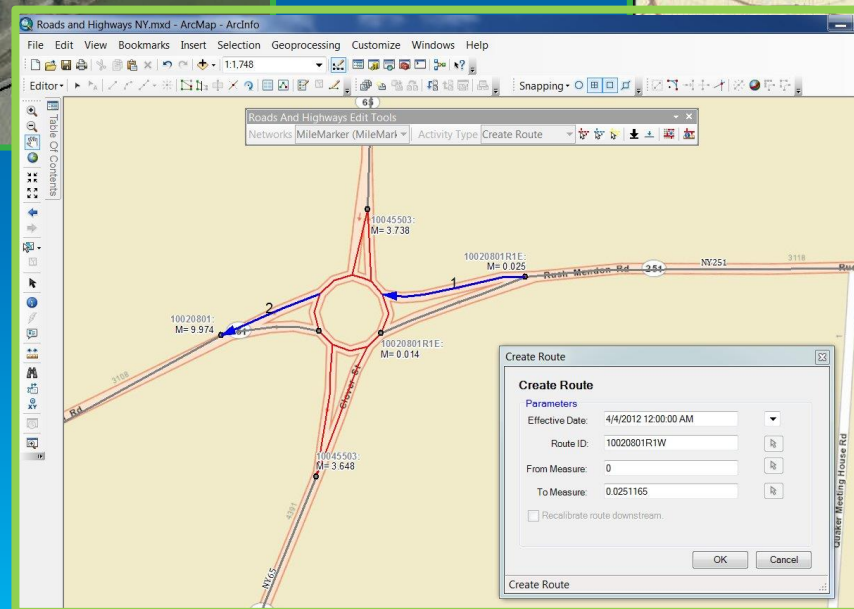
**Periodic upload from local source**



**Redlining using web tools**



**Direct use of  
Roads & Highways**



**Conflation tools used  
as necessary**

**Consolidated data  
provided back to the  
locals**

*Supporting workflows to recognize the GIS capabilities of all involved...*

# Seeing the results

## *Ramps, dual carriageways and local roads*

Esri - Search x ESRI St x New Tab x Welco x UNC x Esri R x Roadw x Esri R x Geom x Measu x Geom x Roadw x Histor x Ohio I x Esri Tr x

ec2-54-242-249-22.compute-1.amazonaws.com/lowa/RCEFull/index.html?config=maint.json

Apps Plenary Videos | 201... LADOTD Project Entry ESRI - Sign In

Esri Roads and Highways v10.2.2.348 - Roadway Characteristics Editor

Map Edit Review

1:36,112

Find Route

Network (LRM): MilePoint Local

Layers Basemap Add Data View Date: Today Identify

Map showing a road network with a highlighted route (green line) and a yellow line. The map includes labels for roads, landmarks, and geographical features. A pop-up window titled "Route Locations" displays details for the selected route.

**Route Locations**

Network (LRM): MilePoint Local

Route ID: 937322

FULL\_NAME: CITY OF WEST DES MOINES, ASHWORTH ROAD, E

Measure: 6.4135915 miles

Min. Measure: 0 miles

Max. Measure: 7.021 miles

Field	Value
Routid	937322
created_user	TOM
created_date	09/22/2014
last_edited_user	TOM
last edited date	09/22/2014

(1 of 2) Go to:

Esri, HERE, DeLorme, USGS, METI/NASA

6:53 AM 10/24/2014

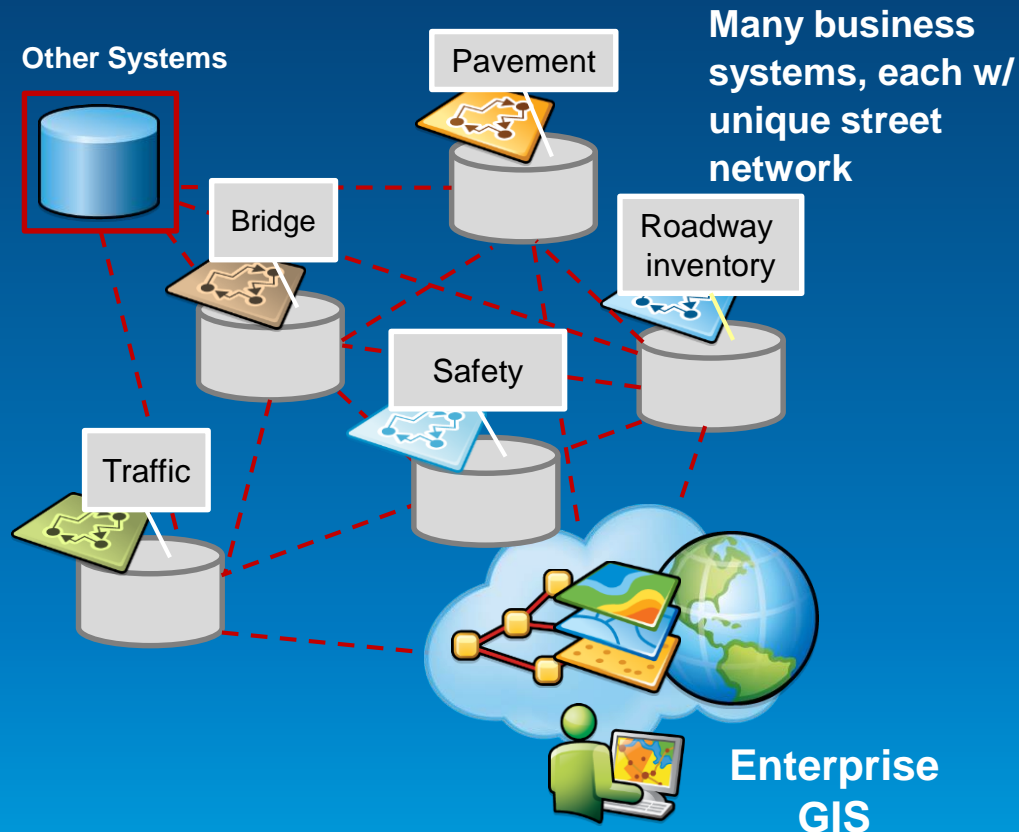


# Integrating Business Systems: Current State

*Trying to achieve better integration*

## Challenges

- Business information remains in silo
- Data not easily accessed by other systems
- Latency in propagation of updates
- Challenging or expensive integration
- GIS not well integrated leading to limited spatial capabilities across enterprise

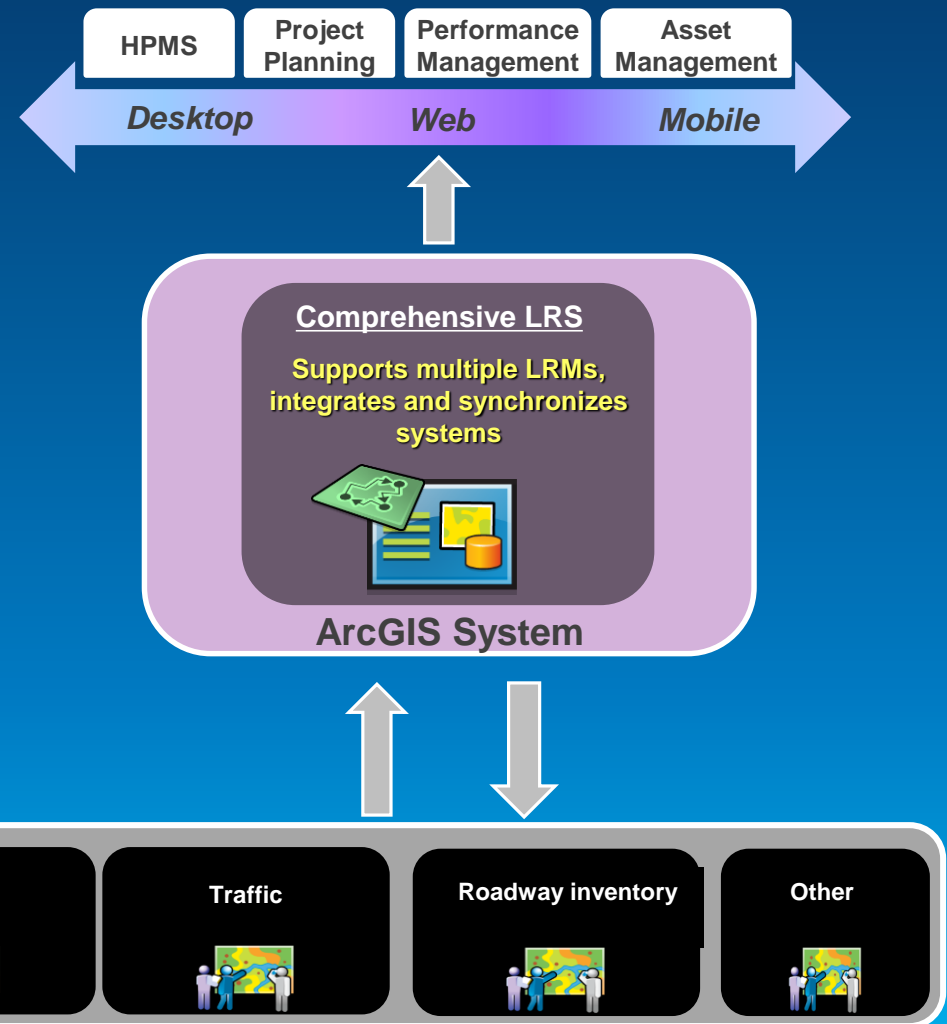


# Integrating Business Systems: Target State

*Unified, foundational, linear referencing 'Platform'*

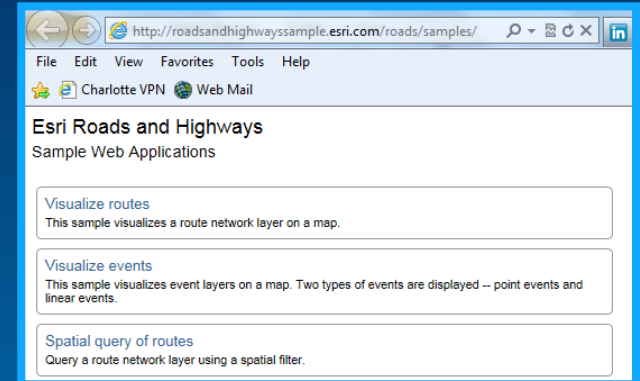
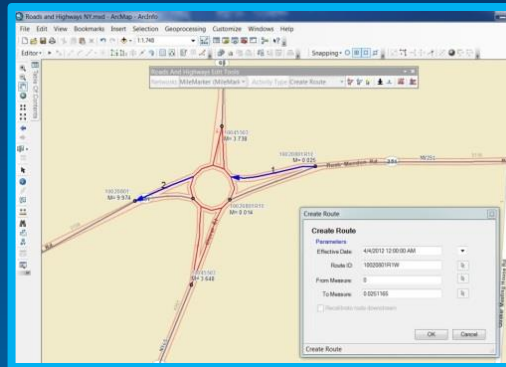
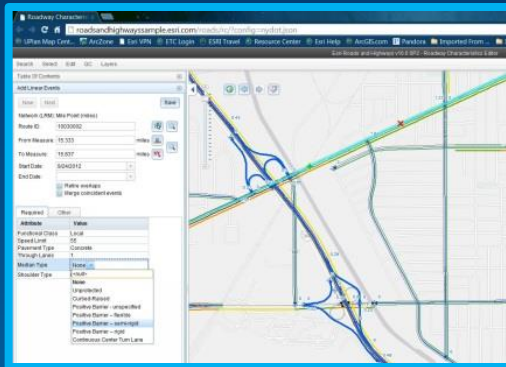
## Benefits

- Common, consistent location reference across all business systems
- Bi-directional data flow
- Data can be consumed by different systems
- Integration simplified
- Consolidation of redundant data
- Standards for system design & procurement
- GIS can serve many systems and functions
- Expanded spatial capabilities across enterprise





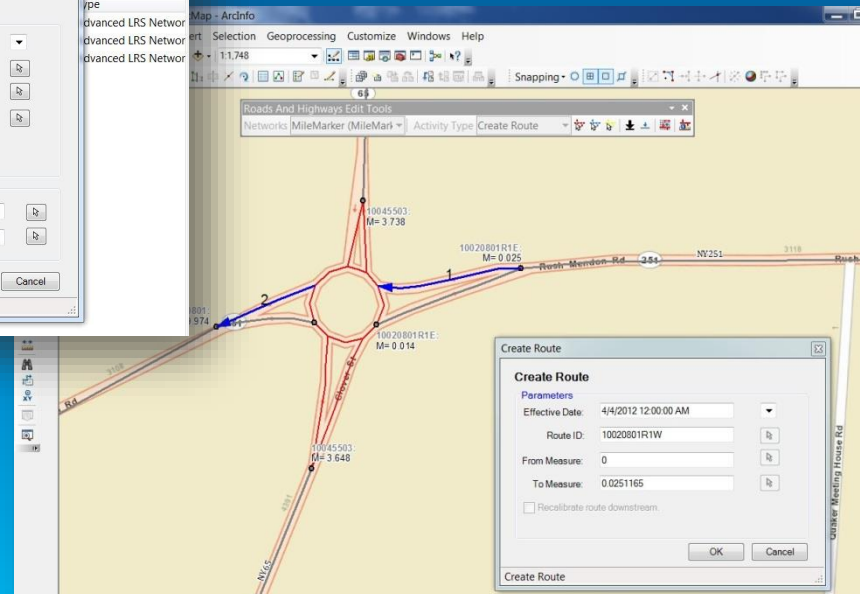
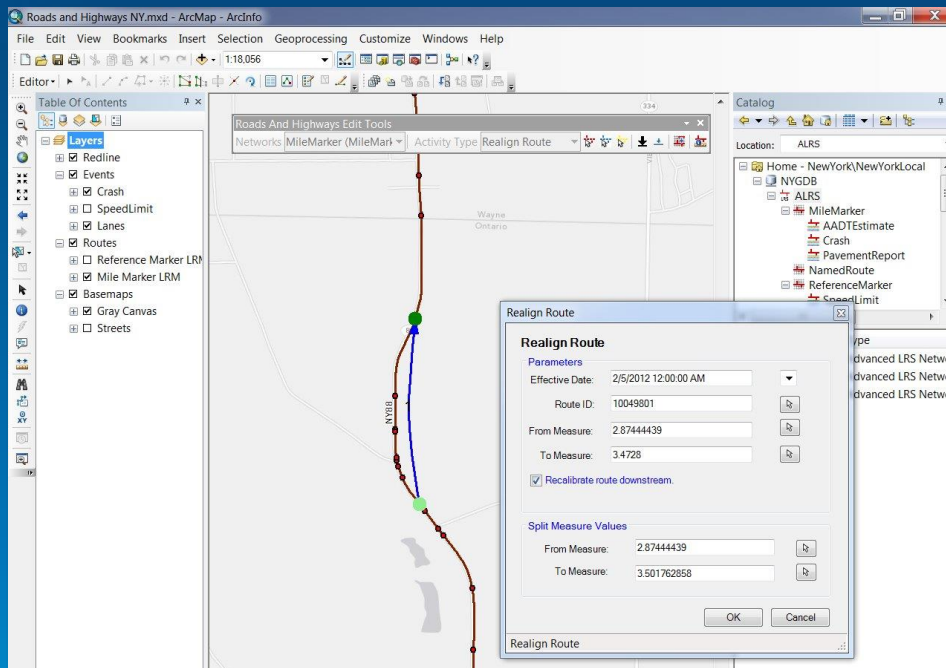
# A new LRS Environment: Roads and Highways



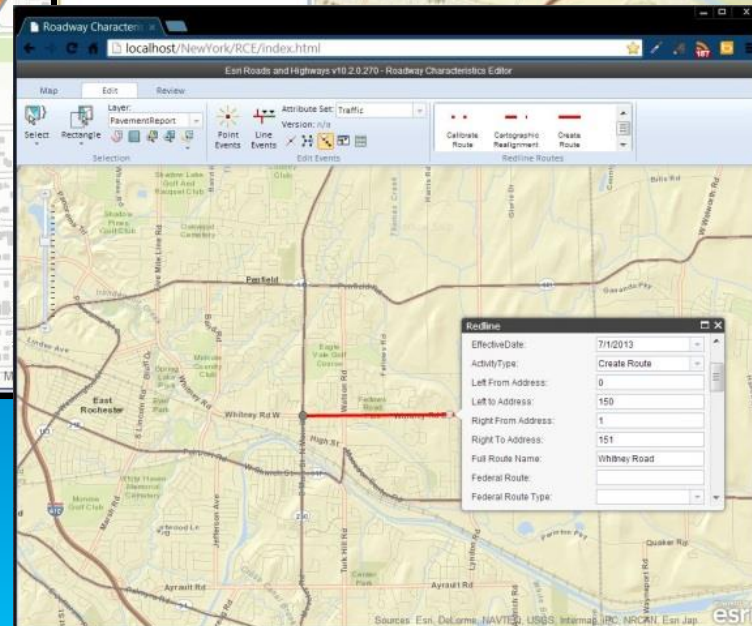
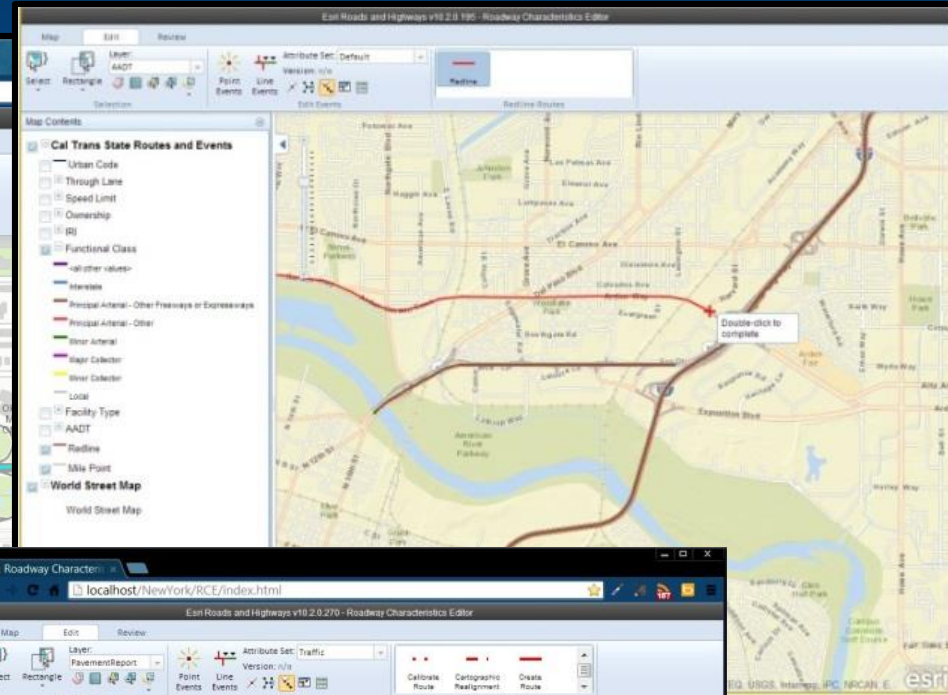
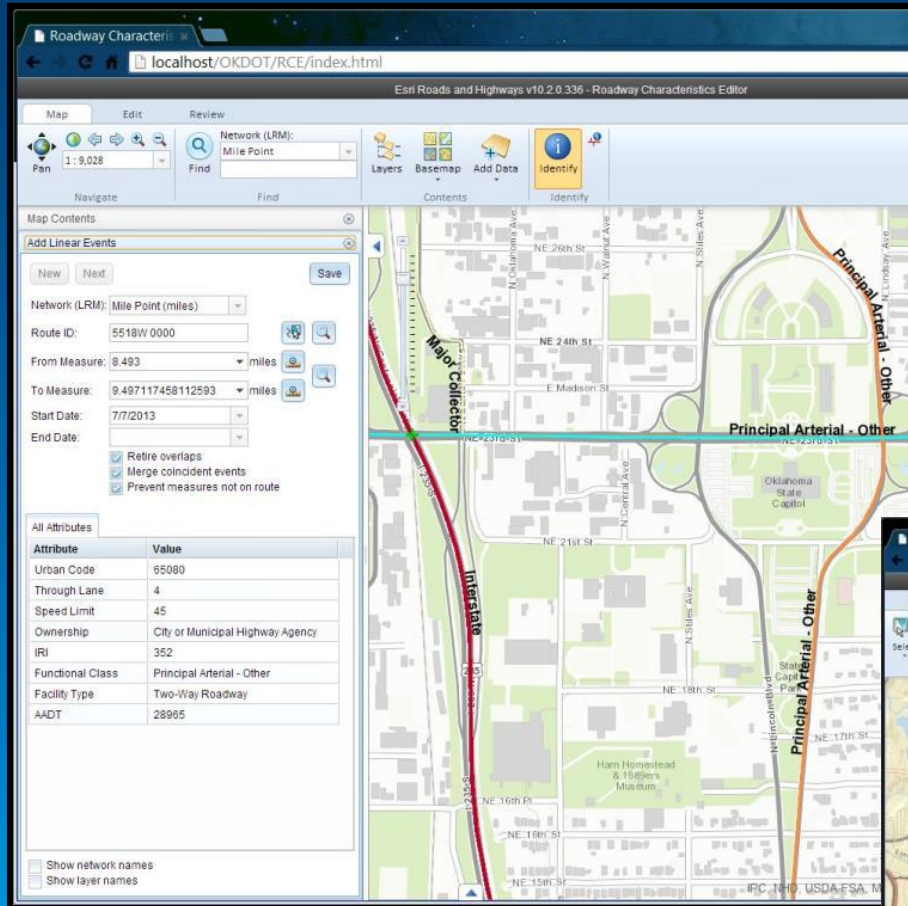
- Focused editing tools for LRS maintenance in the GIS
- Dynamic integration of enterprise business systems
- Automated synchronization of business systems with LRS
- LRS Web Services functionality for collaboration & data quality
- Roadway Characteristics Editing solution
- HPMS Reporting

**A Commercial Off-The-Shelf (COTS) Linear Referencing System (LRS) solution from Esri...**

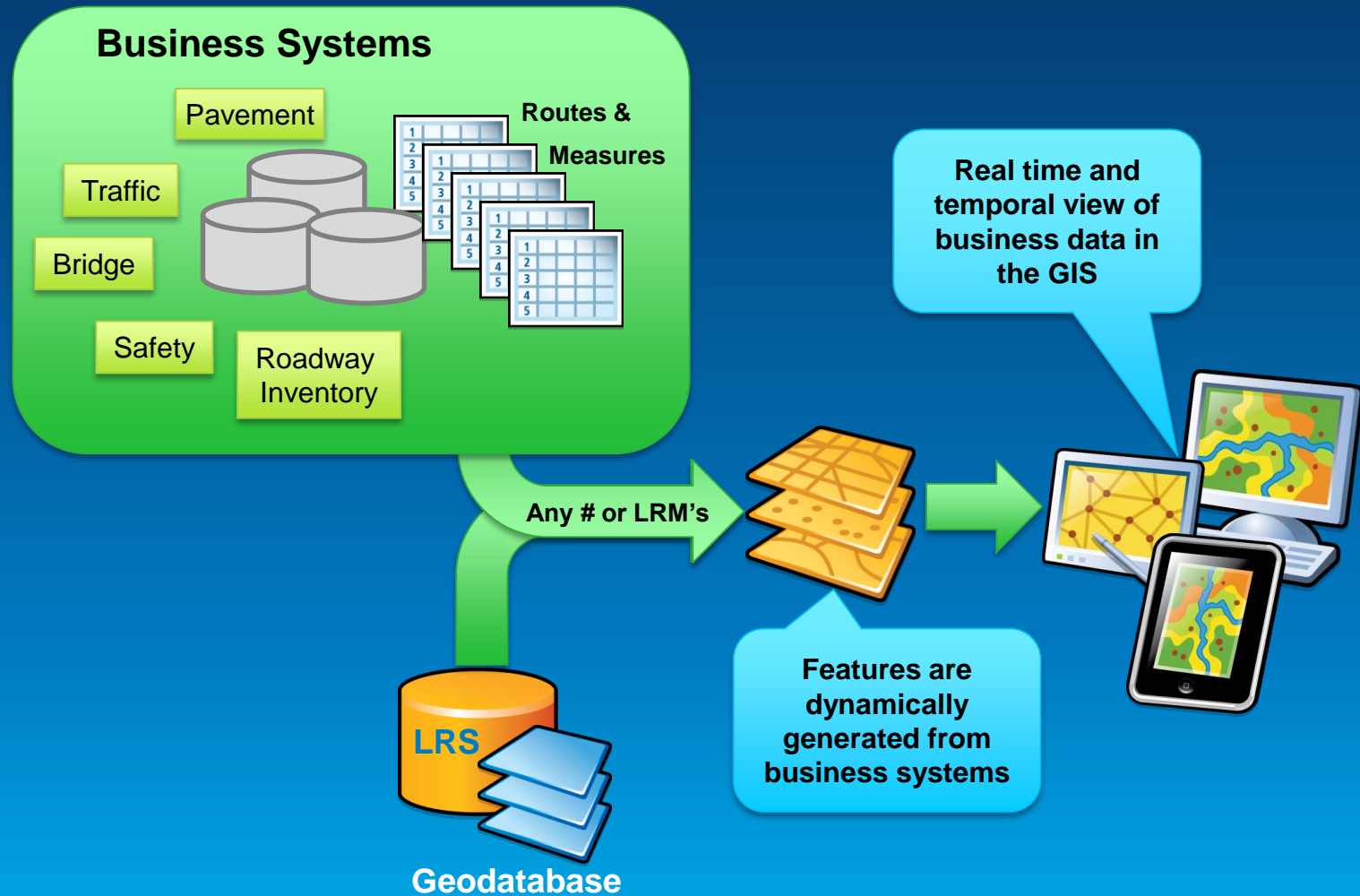
# Focused LRS editing tools



# Roadway Characteristics Editor (RCE)

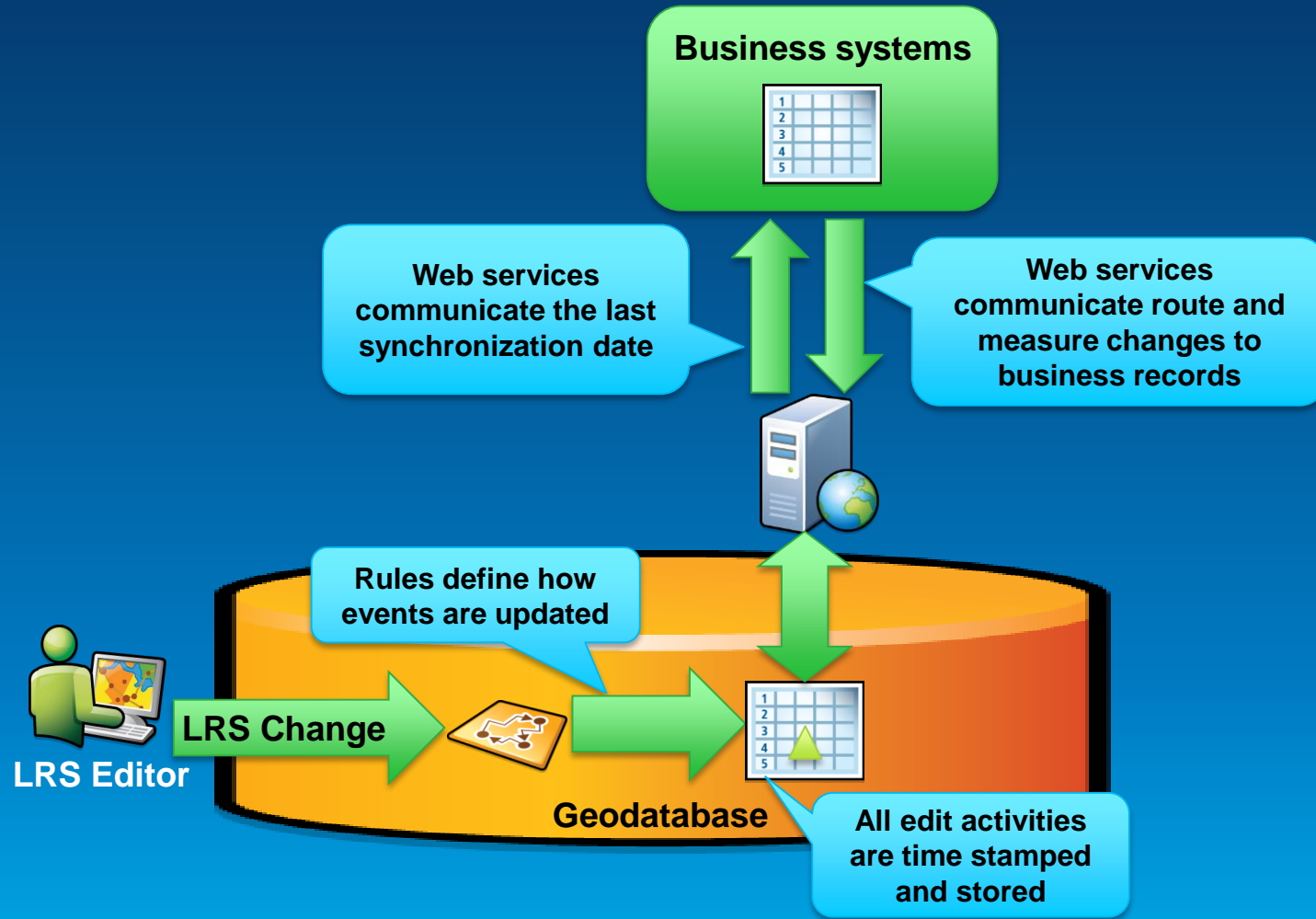


# Dynamic integration of enterprise business systems





# Automated sync'ing of business systems with LRS



# Business Case for a Modernized LRS



## MULTI-LEVEL LINEAR REFERENCING SYSTEM (MLLRS) COST/BENEFIT VALUE ANALYSIS STUDY

*Requested by:*

American Association of State Highway  
and Transportation Officials (AASHTO)

Standing Committee on Highways

*Prepared by:*

Renee L. Hoekstra, C  
RH & Associates, Inc.  
Glendale, Arizona

May 2011

The information contained in this report was prepared as part of  
National Cooperative Highway Research Program, Transportation Research Board

**SPECIAL NOTE:** This report IS NOT an official publication of the  
Highway Research Program, Transportation Research Board, National Academies.

## NCHRP Value Analysis Study

[onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-07\(302\)\\_FR.pdf](http://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-07(302)_FR.pdf)



*Multi-Level Linear Referencing System Cost/Benefit Value Analysis Study - NCHRP Project 20-07, Task 302,  
National Cooperative Highway Research Program, Transportation Research Board*

When expressed as a C/B ratio, the baseline effort yields a C/B ratio of 1.8:1 while the optional functional elements yield an aggregate 21.4:1 ratio of benefits to cost. These figures were generated from empirical values generated by several of the participating states as workshop participants. These aggregate C/B ratios are bound to be different when each particular state is analyzed separately for their own costs versus benefits using their individual operating conditions.

# Robust set of web services for a variety of LRS functions

## Improve data integrity & usability

**Drag and Drop Route Measure Locations**

Drag and drop a csv file with route measure information from windows explorer to the map.

You can download a sample csv file from here: [Inspector notes](#)

RouteID: 58500  
Measure: 1.37664137  
Notes: Light needs replacing  
Longitude: -7951284.53577244  
Latitude: 5135891.041379033

RouteID	Measure	Notes
122100	0.1165	Sing needs replacing
499450	0.2798	Graffiti
6400	34.3806	Damaged sign
6600	0.6223	Light needs replacing
122900	0.5993	Damaged sign
4000	29.97326	Sing needs replacing
58500	1.376644	Light needs replacing
75500	0.609677	Graffiti
24600	4.186886	Damaged guard rail
1400	21.8769	Damaged guard rail
500	6.706772	Graffiti
17400	0.414715	Light needs replacing

**Translate Measures**

Unit of Measure: esriMiles  
Status: OK  
Location: Route ID: 10023605  
Measure: 1.3241

From Network: Named Route  
To Network: Mile Marker  
Route ID: IN278  
Measure: 30  
[Translate](#)

**Result**

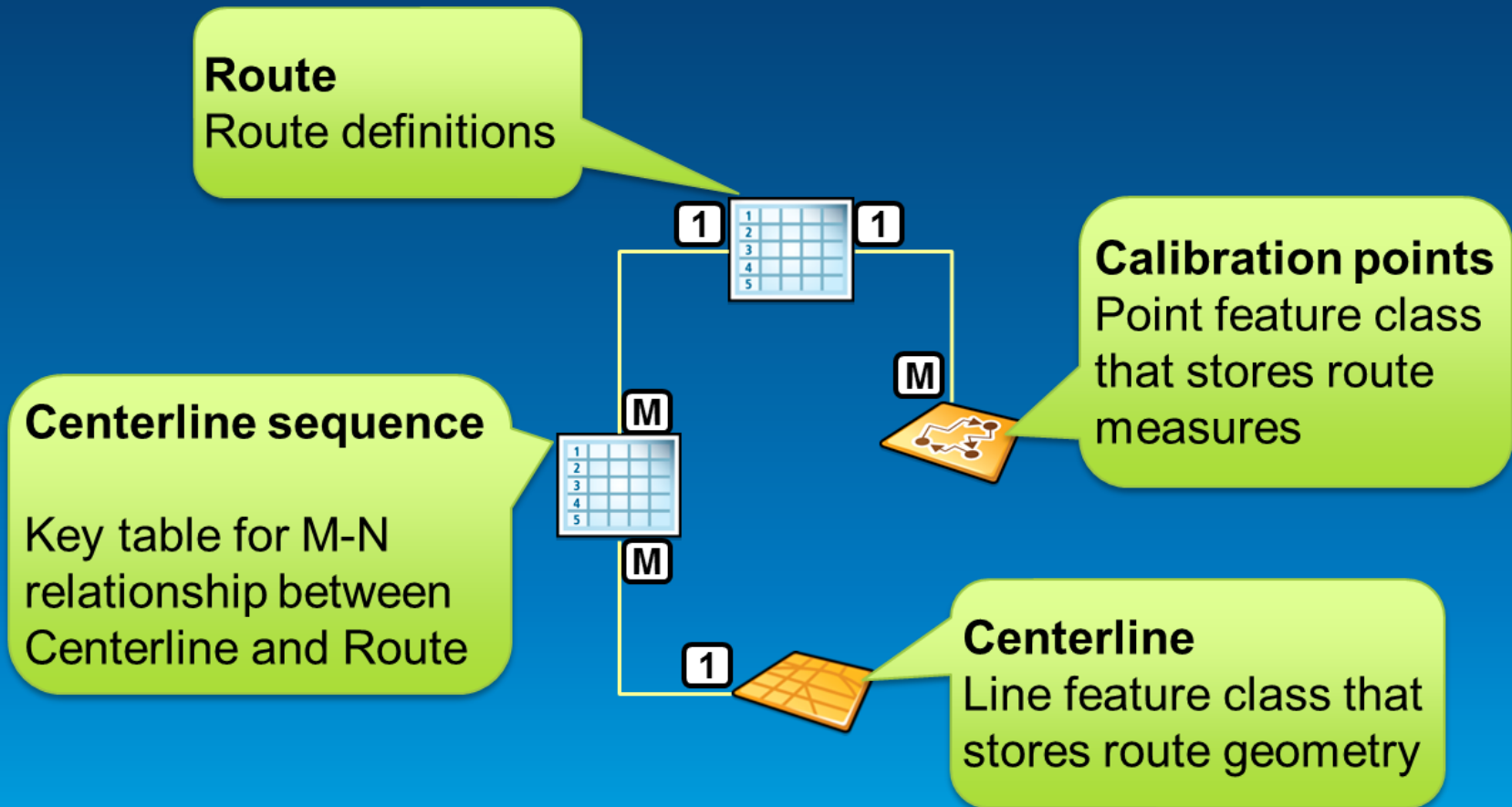
MeasureToGeometry Status: OK  
Geometry: ("X": -8226543.328858199, "Y": 4984549.129375781)  
GeometryToMeasure Status: OK  
Route ID: 10023605

**Esri Roads and Highways Sample Web Applications**

- Visualize routes**  
This sample visualizes a route network layer on a map.
- Visualize events**  
This sample visualizes event layers on a map. Two types of events are displayed -- point events and linear events.
- Spatial query of routes**  
Query a route network layer using a spatial filter.
- Spatial query of events**  
Query an event layer using a spatial filter.
- Attribute query of routes**  
Query a route network layer using an attribute filter (where clause).
- Attribute query of events**  
Query an event layer using an attribute filter (where clause).
- Convert geometry to measure**  
Convert a geographic location into a route measure value.
- Convert measure to geometry**  
Convert route measure values into geographic points and lines.
- Translate network measures**  
Translate measure values between two networks with different units of measure.
- Drag-drop a CSV file of geographic locations**  
Drag-and-drop a CSV file to convert geographic locations into route measures.
- Drag-drop a CSV file of route measures**  
Drag-and-drop a CSV file to convert route measures into geographic locations.
- Event editing**  
Add new event records to an event layer.

# Roads and Highways data model

*Simple, open, easily understood*

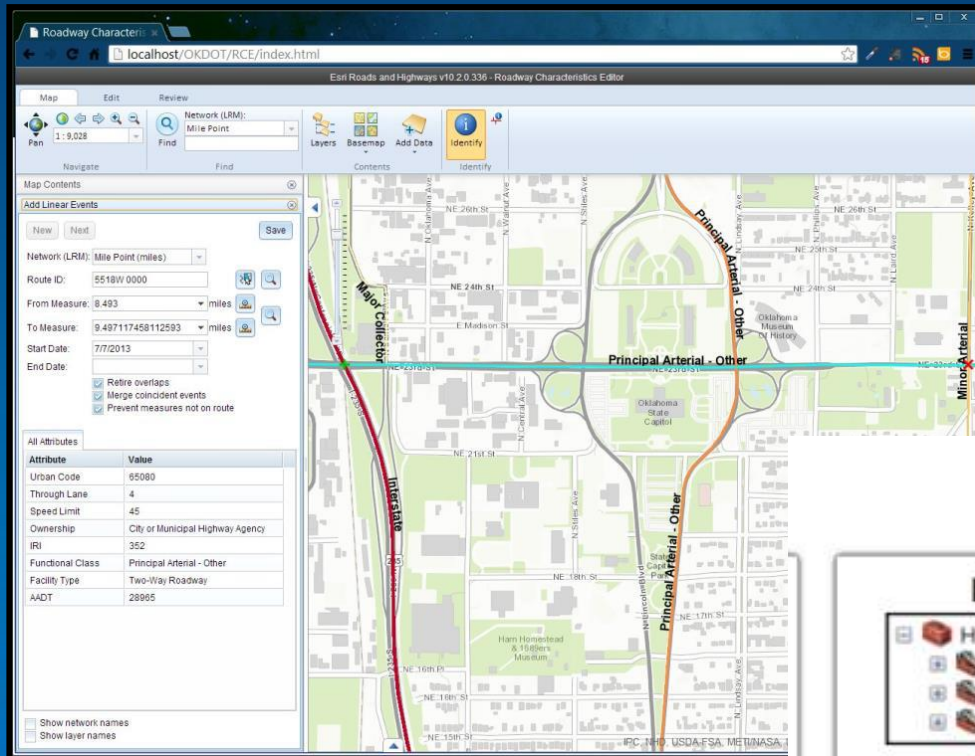


*2 feature classes and 2 tables...*



# HPMS capabilities in Roads and Highways

*Output file formats, HPMS data model, RCE to edit sample sections and inventory*



More Gallery posts ▶

## HPMS

- HPMS 2013
- Sections Catalog
- Shapes Catalog
- Tools (Auxiliary)

2013

HPMS 2013  
Geoprocessing Models



HPMS Data Model

<http://resources.arcgis.com/en/communities/roads-and-highways/>

# COTS Business Applications

The image displays a collage of COTS business applications for roads and highways. The central application is PMG Software Professionals, which shows a road view, a map, and a data table for the 2011 RICHLAND I 26 E BMP. The table includes columns for Total Lanes, Surface Width Left, Median Type, Median Width, Surface Width Right, Functional Class, HPMS Sample, and AADT. The AADT value is 46400. Other applications shown include transmetric, transcend spatial solutions, vueworks, and AGILEASSETS.

**PMG Software Professionals**

2011 RICHLAND I 26 E BMP: 92.186 EMP: 108.245

Attribute	Value
Total Lanes	4
Surface Width Left	24
Median Type	6
Median Width	30
Surface Width Right	24
Functional Class	1
HPMS Sample	84
AADT	46400

**transmetric**

**transcend spatial solutions**

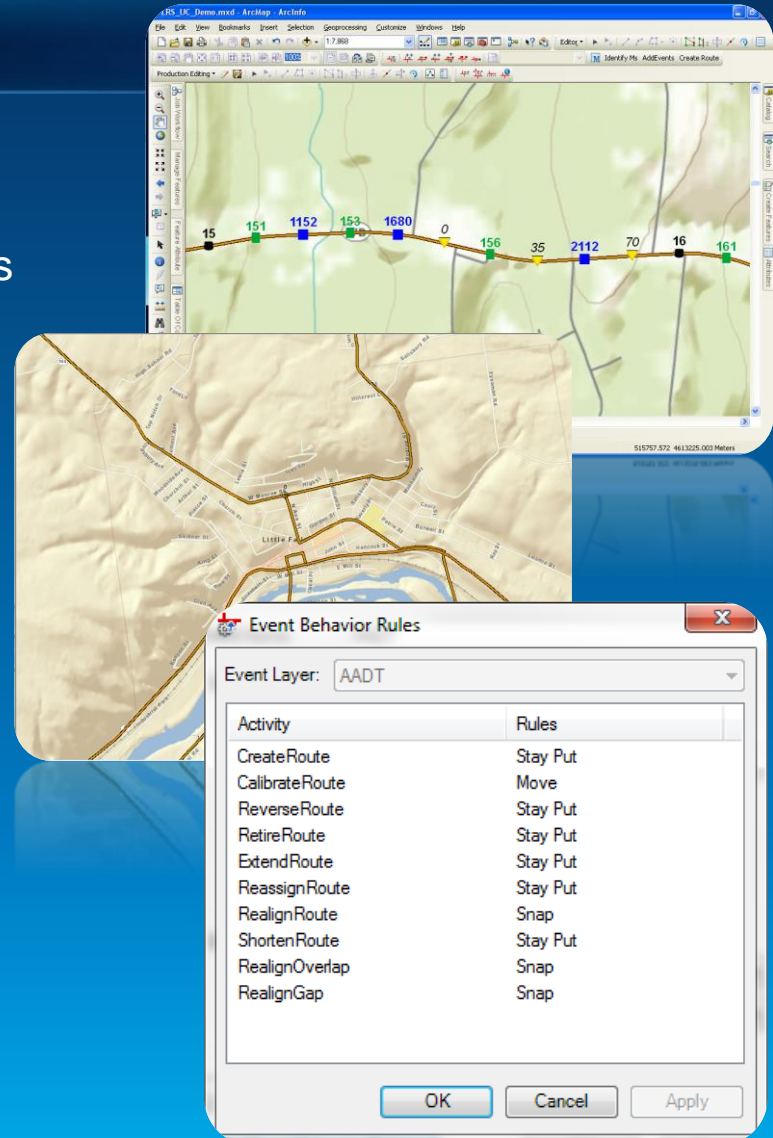
**vueworks**

**AGILEASSETS**

Additional business value for Roads & Highways...

# Advanced Linear Referencing

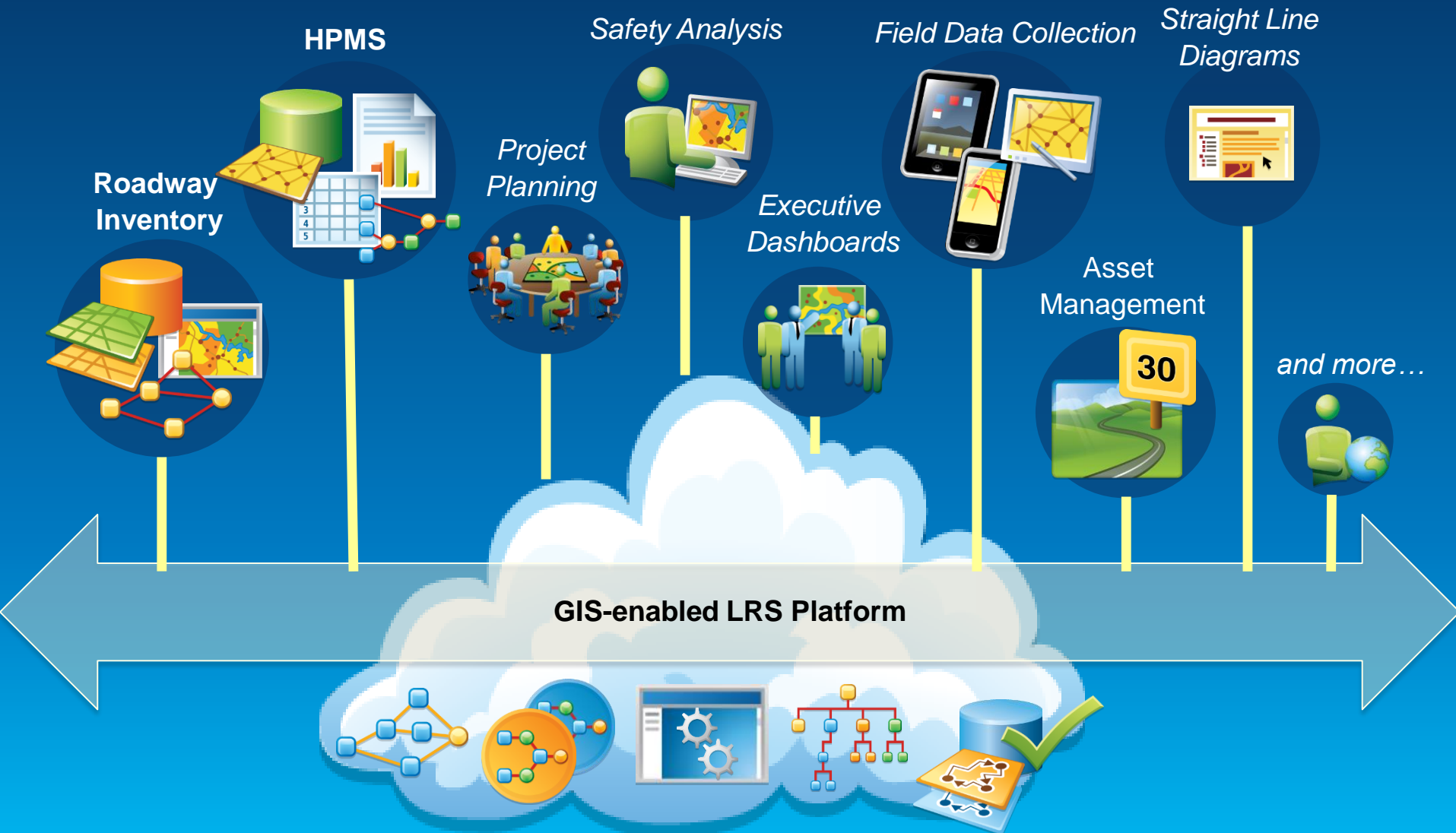
- LRS Data Model
- Built on ArcGIS platform; no other/external tools
- Point feature class that stores calibration measures
- Redline feature class for input of proposed routes
- Any number of LRMs
- Includes Data Reviewer
- Includes Workflow Manager
- Rule-based location management
- Time aware LRS
- Highly configurable
- Robust set of web services for a variety of LRS functions



Supporting a full LRS environment...

# ArcGIS supporting the DOT

*ArcGIS simply includes Linear Referencing System (LRS) capabilities*





# Roads and Highways Interest Level in the U.S.

- **Implementing**
  - North Carolina
  - New York
  - Minnesota
  - Georgia
  - Colorado
  - Alabama
  - Indiana
  - Arizona
  - West Virginia
  - Alaska
  - LBJ Tollway
  - City/County of Denver
  - County of Boulder
- **Implementing**
  - Nevada
  - Kansas
  - Vermont
  - Virginia
  - Washington
  - Massachusetts
  - Rhode Island
  - Ohio
  - Wyoming
  - Louisiana
  - Maryland
  - DC DOT
- **Involved discussions**
  - Delaware
  - North Dakota
  - Oregon
  - South Dakota
  - Idaho
  - Utah
  - Iowa
  - Oklahoma
  - New Mexico
  - NJ Turnpike
- **Radar screen**
  - Maine
  - California
  - Michigan
  - Kentucky
  - Wisconsin
  - Texas
  - WMATA
  - FHWA



# Questions

**Gary A. Waters**  
**National Account Executive**  
**Transportation Practice**  
**Esri**  
[gwaters@esri.com](mailto:gwaters@esri.com)  
**678-332-7225**